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MODIS On-orbit Calibration: Key Issues and Approaches

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ABSTRACT

MODIS, one of the key instruments for the NASA's Earth Observing System (EOS), is currently operating on both the Terra and Aqua spacecraft making continuous observations in 36 spectral bands from 0.4 to 14.5μm. A complete suite of on-board calibrators (OBC) have been designed for the instruments on-orbit calibration and characterization, including a solar diffuser (SD) and solar diffuser stability monitor (SDSM) system for the radiometric calibration of the 20 reflective solar bands (RSB), a blackbody (BB) for the radiometric calibration of the 16 thermal emissive bands (TEB), and a spectro-radiometric calibration assembly (SRCA) for the spatial (all bands) and spectral (RSB only) characterization. The task of continuously performing high quality on-orbit calibration and characterization of all 36 spectral bands with a total of 490 detectors located on four focal plane assemblies is extremely challenging. The use of a large two-sided paddle wheel scan mirror with a ±55° scan angle range and a retractable pinhole attenuation screen in front of the SD panel for calibrating the high gain bands have resulted in additional unanticipated complexity. In this paper, we describe some of the key issues in the Terra and Aqua MODIS on-orbit calibration and characterization, and discuss the methods developed to solve these problems or to reduce their impact on the Level 1B calibration algorithms. Instrument performance and current issues are also presented.

Keywords: MODIS, EOS Terra, EOS Aqua, radiometer, on-board calibrators, calibration, solar diffuser, blackbody

1. INTRODUCTION

Two Moderate Resolution Imaging Spectroradiometer (MODIS) instruments are currently operating on-orbit, making major contributions to the NASA's Earth Observing System (EOS) missions. The MODIS Protoflight Model (PFM) was launched in December 1999 onboard the EOS Terra spacecraft in a morning orbit (local equator crossing time of 10:30AM) and the Flight Model 1 (FM1) in May 2002 onboard the EOS Aqua spacecraft in an afternoon orbit (local equator crossing time of 1:30PM). The continuous observations from both Terra and Aqua MODIS have enhanced the science and research communities' capability in their studies of the Earth as a system (land, oceans, and atmosphere). Compared to its heritage sensors, such as the Advanced Very High Resolution Radiometer (AVHRR) and the Sea-viewing Wide Field of View Sensor (SeaWiFS), the MODIS covers a broader spectral range with three different spatial resolutions and has improved temporal resolution[1-3].

Both Terra and Aqua MODIS have 36 spectral bands with wavelengths from 0.41 to 14.5_ distributed on four focal plane assemblies (FPAs) according to their wavelengths: visible (VIS), near infrared (NIR), short- and mid-wave infrared (SMIR), and long-wave infrared (LWIR). Bands 1-19 and 26 are the reflective solar bands (RSB) and the others, bands 20-25 and 27-36, are the thermal emissive bands (TEB). Table 1 provides a summary of these bands, including their primary science applications, spectral wavelengths, number of detectors in each band, the instantaneous field-of-view (IFOV) or spatial resolution, location on the FPAs, specified typical radiance, and corresponding required signal-to-noise ratio (SNR) for the RSB or noise equivalent difference temperature (NEdT) for the TEB.

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